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CLAUSEWITZ ON SPACE:

DEVELOPING MILILTARY SPACE THEORY THROUGH A COMPARATIVE ANALYSIS

by

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America has been in space for over 40 years, yet there seems to be little common understanding of how to integrate space into all aspects of military operations. A common vision for the military application of space forces is vital for America in a period of growing space reliance and decreasing space budgets. Our fielded forces rely on space for a variety of essential missions including communications, intelligence, weather, navigation and missile warning. Our commercial space industry has become a huge economic center of gravity for our nation. Our enemies are discovering the benefits of space by developing their own systems and purchasing commercial space services. We face the daunting challenge of expanding our exploitation of space and protecting our existing space assets, while operating in a fiscally constrained environment. We face this challenge today without a common vision of how to use space. America?s space effort is divided between the Department of Defense (DOD) (led by U.S. Space Command), the National Reconnaissance Office (NRO), the National Aeronautics and Space Administration (NASA) and commercial industry. Each group has its own motivations and priorities that come into conflict at times. Prussian military theorist Carl von Clausewitz and others believed sound theory was the key to providing a common vision of military operations to all members of an organization. This paper seeks to provide some keys to space theory in order to create a common vision of the effects of space on military operations.

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Preface

Space systems affect almost every member of our armed forces, from providing precision navigation and global communications, to weather information, missile warning, and intelligence. Many of these same people, however, do not have a good understanding of how these effects are provided. They rely daily on data from space, but do not understand how space systems provide that data. I believe the key to effective integration of space systems into the battlefield is to understand the theory behind how space systems affect the battlefield. I believe this space theory can be developed from the works of classical theorists Carl von Clausewitz, who defined key war theory concepts and Julian Corbett, who adapted some of Clausewitz's original land-based concepts for warfare at sea. This space theory can then be linked to current Air Force doctrine to provide a sound understanding of how space systems affect the battlefield. Understanding this theory will allow us to better integrate space forces with land, sea and air forces by considering how the effects provided by each force contribute to the overall effect desired by the Joint Force Commander. We can also understand how to secure the effects of space systems for ourselves and deny them to our enemies.

I want to thank Major Ed Greer, my research advisor for his help and guidance, my wife Liz for her constant support and patient proof reading and all the men and women, military, government civilian and contractor, with whom I have been privileged to serve in the last 12 years. America's preeminence in space is because of you.

Abstract

America has been in space for over 40 years, yet there seems to be little common understanding of how to integrate space into all aspects of military operations. A common vision for the military application of space forces is vital for America in a period of growing space reliance and decreasing space budgets. Our fielded forces rely on space for a variety of essential missions including communications, intelligence, weather, navigation and missile warning. Our commercial space industry has become a huge economic center of gravity for our nation. Our enemies are discovering the benefits of space by developing their own systems and purchasing commercial space services. We face the daunting challenge of expanding our exploitation of space and protecting our existing space assets, while operating in a fiscally constrained environment. We face this challenge today without a common vision of how to use space. America's space effort is divided between the Department of Defense (DOD) (led by U.S. Space Command), the National Reconnaissance Office (NRO), the National Aeronautics and Space Administration (NASA) and commercial industry. Each group has its own motivations and priorities that come into conflict at times. Prussian military theorist Carl von Clausewitz and others believed sound theory was the key to providing a common vision of military operations to all members of an organization. This paper seeks to provide some keys to space theory in order to create a common vision of the effects of space on military operations.

Chapter 1

Space and the War Fighter

"...in the future, whoever has the capability to control space will likewise possess the capability to exert control on the surface of the earth.

—General Thomas D. White, Chief of Staff, US Air Force
29 November 1957

Introduction—The DESERT STORM Experience

Over forty years after the United States launched its first satellite in 1958, our armed forces are as dependent on space power as they were on airpower 40 years after the Wright Brothers' first flight in 1903. The aircraft carrier battles of the Coral Sea and Midway, the Battle of Britain and the beginning of the strategic bombardment of Europe by 1943, had shown the effect airpower could have on the battlefield. If World War II demonstrated the potential of airpower, then Operation DESERT STORM in 1991 demonstrated the potential of space power. American troops depended on a wide variety of space assets for critical missions such as navigation, weather forecasting, communications, ballistic missile warning and intelligence. General Thomas F. Moorman, Jr., Commander of Air Force Space Command during DESERT STORM and later Vice Chief of Staff of the Air Force, said:

> DESERT STORM was a watershed event for military space applications because for the first time space systems were both integral to the conflict and critical to the outcome of the war.[1]

However, DESERT STORM also highlighted problems with our use of space power. DESERT STORM forces were at first unable to get timely weather and imagery intelligence data because shipment of the necessary user equipment to theater was given a low priority in pre-war logistics planning.[2] The first warnings of an Iraqi Scud missile launch were delivered about one and a half minutes after the missile had already hit its target area because our space-based missile warning system was designed to provide warnings to CONUS, not to troops in the field.[3] High demand for Global Positioning System (GPS) satellite navigation receivers outstripped our ability to produce military receivers. Troops were issued commercial receivers in many cases and some even had them sent from family back home. In spite of these problems, space assets proved essential to victory in DESERT STORM. Maximizing the effects of space in future battles will require more people to have a better understanding of how to apply space systems.

Towards a Common Understanding

> *{Theory's} main practical value is that it can assist a capable man to acquire a broad outlook whereby he may be surer his plan shall cover all the ground and whereby he may with greater rapidity and certainty seize all the factors of a sudden situation.*
>
> —Julian S. Corbett

I believe the key to maximizing the effect of space on military operations lies in a common understanding of space at all levels of command in the armed forces. It is not enough for space operators to understand space; all space users must understand it as

well. In this paper, I will seek to provide that common understanding by identifying the keys to military space theory. This theory and its linkage to Air Force doctrine will hopefully pave the way for a better understanding of how space can be integrated into military operations. I will start by briefly discussing the capabilities provided by space systems today and the organizations that provide them. I will then highlight the uniqueness of the space medium, show how it differs from the air medium and how those differences impact space system operations. This will be followed by a comparative analysis to show how space theory can be derived from existing classical theories and how this theory links to current Air Force doctrine. I will conclude by presenting what I think are the keys to military space theory now and in the future. These keys contain the essential elements necessary for commanders at all levels to integrate space into the battlefield.

The Effects of Space on the War Fighter

Space systems provide a variety of effects for the war fighter, yet these effects are often hard to visualize. It is easy to visualize the effects of airpower. We can "see" an A-10 kill an enemy tank and we can "see" an F-15 shoot down a hostile aircraft. Most people in the military have experience with the effects of space but do not understand just how those effects are achieved. They cannot visualize the Defense Support Program (DSP) satellite detecting a Scud launch with its infrared telescope, then reporting that launch to the field through a worldwide system of ground stations. The only aspect of that huge DSP system most troops will see is the "Scud Launch" warning passed via message traffic, pager or the base warning siren. The launch warning is the "effect" that the DSP space system provides to troops in the field. Similarly, everyone has watched

Navy Tomahawk cruise missile launches on TV, but few have seen how data from a variety of space systems enables these weapons to strike with great precision from hundreds of miles away.[4] Data from space systems is also the primary ingredient in creating most of the maps and charts used by military forces for navigation on land, sea and through the air.

Most people view space systems like an army infantryman views the infrastructure behind an A-10. The infantryman knows there is an airfield from which the A-10 took off and he also knows that there is a complex air traffic control and battle management system that directs the A-10 to his location at a certain time. All he really sees (and cares about), however, is the effect provided by the aircraft flying over his head, protecting him from enemy armor attack. People do not see space systems flying over the battlefield, which often makes it difficult to relate the effects of space directly to space systems. Figure 1 summarizes the key effects of space systems on military operations.

The Space System

One must understand the basics of a space system to understand the effects of space. Each space system consists of a space segment, a ground control segment, a data processing segment, a user segment and links between the segments. See Figure 2 below.

Space Segment

The space segment consists of one or more satellites in space. A satellite may contain multiple payloads contributing to a common mission, or it may contain multiple payloads designed for different missions. Satellites of the Defense Meteorological Satellite Program (DMSP) have multiple sensors dedicated to weather monitoring. Global

Positioning System (GPS) satellites carry payloads to detect above-ground nuclear explosions in addition to their primary navigation system payloads. The space segment receives commands from the ground control segment via the command or telemetry, tracking and command (TT&C) link. Data is provided to the ground processing and/or user segment via the data and/or user links.

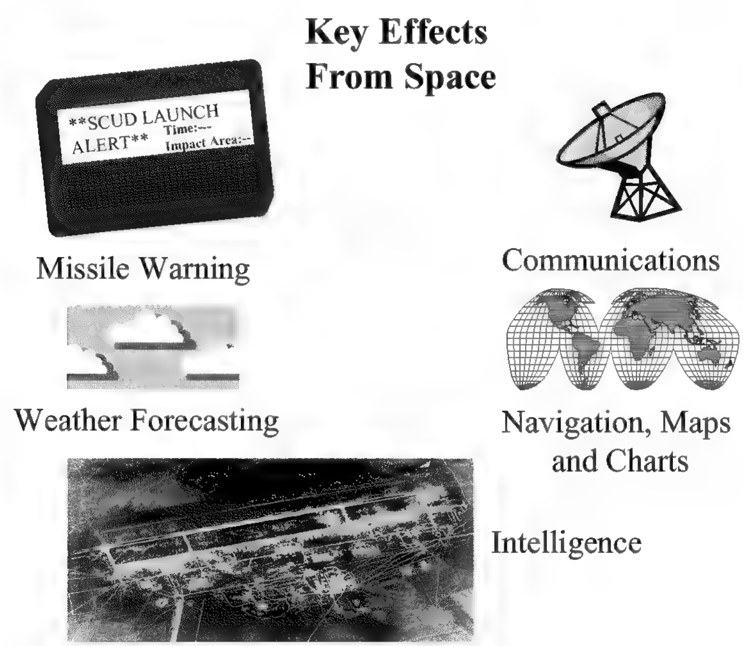

Figure 1. Space Effects on the War Fighter

Ground Control Segment

The ground control segment monitors the health and status of the space segment and regularly provides commands to each satellite via the command link. This link may be via an antenna co-located with the ground control segment or it could be via one of the many Air Force Satellite Control Network (AFSCN) stations located around the world. The complexity of the ground control segment usually depends on the complexity of the space segment. Some Air Force research satellites have had ground control segments

consisting of only a personal computer and a single transceiver.[5] The GPS ground control segment consists of multiple installations located around the world. Personnel located at the ground control segment are the operators of the space segment, but they are often not the users of the data coming from the space segment. For example, the GPS master control station is located at Schriever AFB, Colorado, while the many, many users of GPS data are located all over the world. These operators are like the air traffic controllers and battle managers directing the A-10. They have a huge impact on how the system is used, but they usually do not directly benefit from the use of the system.

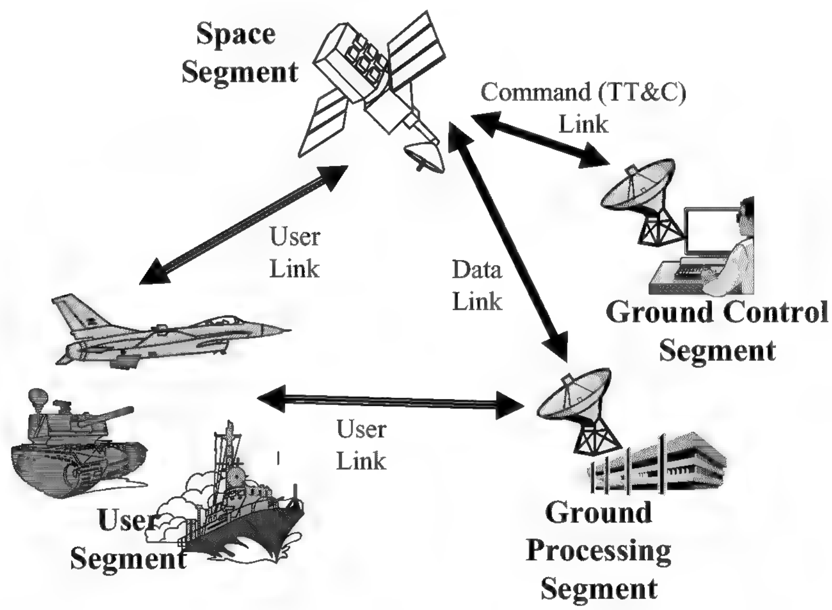

Figure 2. Segments and Links of a Space System

Ground Processing and User Segments

The ground processing and user segments take data from the space segment and process it into a format suitable for the user. These segments have the largest impact on the user of space capabilities because they determine the way in which a user gets data

from space and the format of that data. These segments are usually the only part of the space system the user ever sees. To most users these segments *are* the space system. Key considerations for the ground processing and user segments are their location with respect to the user, their size and cost and the relative complexity of data processing.

The ground processing segment may be co-located with the user segment or it may be some distance away. Distance between the ground processing segment and the user segment often poses a problem with data timeliness. The delays encountered in sending warning messages to U.S. forces targeted by Iraqi Scud launches, for example, were due in large part to the distance between the DSP ground processing segment in CONUS and U.S. forces in Saudi Arabia.[6]

The size of each ground processing and/or user segment impacts the number of systems you can afford and how easy it is to deploy the system into theater. GPS receivers, which perform some of the ground processing and all the user segment functions, fit easily into the pocket of a battle dress uniform. The equipment necessary to receive near-real-time National imagery intelligence in theater during DESERT STORM required a C-5 aircraft to transport it.[7] The number and duration of steps it takes to process the space data also impacts the data's cost and timeliness. Creating a map or chart from space data, for example, requires many powerful computers and hundreds of man-hours of effort.[8]

The cost of a ground processing or user segment is usually only a small fraction of the total cost of the space system. This has caused consternation among space users in the past. They see billions of dollars spent on space, yet they know their user and ground processing systems cost anywhere from a few million to only a few hundred dollars. This

is because these users see so little of the huge infrastructure that goes into providing effects from space. The 24-satellite GPS constellation and worldwide ground control system for example, cost billions of dollars. A civilian GPS receiver costs as little as $150. The effect of precision navigation provided by that receiver, however, would be lost without the multi-billion dollar infrastructure behind it.

Links

The links between each of the segments in Figure 2 are usually made via radio communications. The link between the ground processing segment and the user segment may also be via landline communications. These links are vital because loss of a link is just as damaging as the loss of a segment. Loss of the downlink from a satellite would deny data to a user just the same as if the satellite were disabled in orbit or the in-theater ground processing or user segment were destroyed in an air raid or by terrorists. Military planners must consider these vulnerabilities when planning operations requiring space capabilities. All segments and links of the space system must be protected to ensure the effect provided by the space system. Likewise the segments and links of an adversary's space systems can become key targets for attack.

Organizations Supporting Military Space Efforts

A major challenge facing space system users today is the variety of organizations that provide space-related support for the military. U.S. Space Command (USSPC) manages most of our space infrastructure including launch facilities, space surveillance sites, and tracking stations. It provides daily control for GPS, DMSP, DSP, Milstar and other unclassified military satellites. The National Imagery and Mapping Agency

(NIMA) provides imagery intelligence and space-derived mapping, charting and geodesy data. NIMA also manages acquisition of commercial space imagery for the DOD. The Defense Information Systems Agency (DISA) contracts for commercial communication satellite support for DOD operations. The NRO collects national intelligence from space. Other organizations such as the National Security Agency, the National Oceanographic and Atmospheric Administration (NOAA), and the National Aeronautics and Space Administration (NASA) are involved as well.

These organizations provide different capabilities needed by the military user. Each organization has its own priorities and a different chain of command. This makes it impossible for one organization to represent all of space to a Joint Force Commander (JFC). Air Force Doctrine Document 2-2, Space Operations, highlights this issue:

> Assets not assigned to service components make up an increasing portion of the space systems capabilities available to the theater commander. These include, but are not limited to, US national systems, leased commercial assets, or multinational force assets.[9]

Today, for example, a JFC can get communications satellite service from USSPC using military satellites or DISA using commercial communications satellites. The process for the JFC to get imagery intelligence includes passing collection requirements to NIMA, who then prioritizes and forwards the requirements to the NRO, who in turn collects the appropriate data and passes it to NIMA for dissemination. These situations occur on a daily basis during both peacetime and conflict.[10]

Numerous members of the JFC's staff are involved in this process as well. The J6, Computers and Communication, handles communication requirements. The J2, Intelligence, handles space-based intelligence requirements. There is no single staff department or organization that the JFC can turn to for all his space needs. The recent

addition of a Space Warfare Officer to the Joint Force Air Component Commander (JFACC) staff helps but does not fully resolve this problem.[11] Therefore, commanders and staff at all levels need to have a basic knowledge of how to plan, manage and maximize the effects of space. Part of this basic knowledge includes understanding the space medium and how the unique characteristics of that medium affect space systems supporting military operations on land, sea and in the air.

Notes

[1] Air Force Doctrine Document (AFDD) 2-2, *Space Operations*, (Maxwell AFB, AL: Headquarters Air Force Doctrine Center, 1998), 25.

[2] R. Cargill Hall and Jacob Neufeld, eds., *The United States Air Force in Space 1945 to the 21st Century,* (Andrews AFB, MD: USAF History and Museums Program, 1995), 108.

[3] Ibid., 118.

[4] Space-based intelligence assets allow us to analyze targets located in areas where we are denied land access or overflight. DMSP satellites give us the latest weather information. GPS satellites provide precision navigation to and from a target. GPS provides guidance for many types of precision guided munitions. Precision guidance for Tomahawk cruise missiles is also provided by Digital Scene Matching Area Correlation maps, which are created from space data.

[5] Air Force Space Test Program Mission P87-2, launched 11 Apr 90 had a ground segment consisting of one personal computer connected to a single transceiver which provided all satellite command functions. The only external service required was satellite on orbit positioning data from the US Space Command Space Surveillance Network.

[6] Since Desert Storm the Army and Marines have fielded a system called JTAGS (Joint Theater Air Ground System) which allows DSP data to be sent directly from the satellite to theater, thus greatly reducing time it takes for a warning to be sent after a launch is detected.

[7] The Defense Dissemination System III Receive Location and the communications gear necessary to feed data to it were contained in large transportable shelters that only fit on a C-5.

[8] The National Imagery and Mapping Agency's Digital Processing Segment contains more than a dozen different computer systems which process overhead imagery to create maps and charts. The total process from image collection to map production may take more than a year because of the many steps involved in collection and processing the data, turning it into a map via digital cartography and distributing the updated map.

[9] AFDD 2-2, 6.

Notes

[10] NIMA receives collection requirements for and disseminates thousands of images per day in this manner, utilizing the Imagery Exploitation Support System and the Defense Dissemination System.

[11] Major Mark Harter, former Space Warfare Officer for 13th Air Force (PACAF), interviewed by author 8 March 1999. Today most Numbered Air Force staffs have a Space Warfare Officer (SWO) who provides expertise during operations planning and execution. This expertise includes coordinating support provided by all USSPC assets to theater, coordinating commercial SATCOM support through DISA and analyzing intelligence on enemy space capabilities to assist in targeting. It does not include managing the collection of intelligence by space assets. That is handled by the A2/J2. A deployed space support team augments the SWO in times of crisis. Future plans call for the SWO to have an expanded full-time staff to better support the integration of space assets in theater.

Chapter 2

The Space Medium

AFDD 1-1, *Air Force Basic Doctrine,* declares air and space to be a "seamless" medium. There are, however, significant physical differences between the mediums of air and space. These physical differences greatly impact the design and operation of equipment in each medium. There are also enormous differences in how international law governs operations in air and space. Commanders and operators must understand the differences between these media if they are to successfully plan and conduct integrated air and space operations.

Space is a Different Place

> *The difference between (the) atmosphere and space is obvious but where the transition takes place is not.*
>
> Air Force Manual 1-1

Many arguments have been made about where the earth's atmosphere stops and where space begins. There is no universally accepted answer concerning the division between the two media. Physics really draws the line. Space begins where the laws of orbital mechanics, rather than the laws of aerodynamics, govern the movement of vehicles.

The most important operational impacts of the air-to-space transition are the limits placed on vehicle maneuverability by the satellite orbit, the path the satellite follows as it goes around the earth. When a satellite is placed in a particular orbit, it will remain there for its entire operational life. Enormous amounts of energy (meaning fuel to create thrust from a satellite's engines) are required to change the orbit in any significant way. Only minor changes in altitude are usually performed. Figures 3 and 4 show the primary types of satellite orbits. Each orbit has its advantages and disadvantages. The exact orbit used depends on mission requirements.

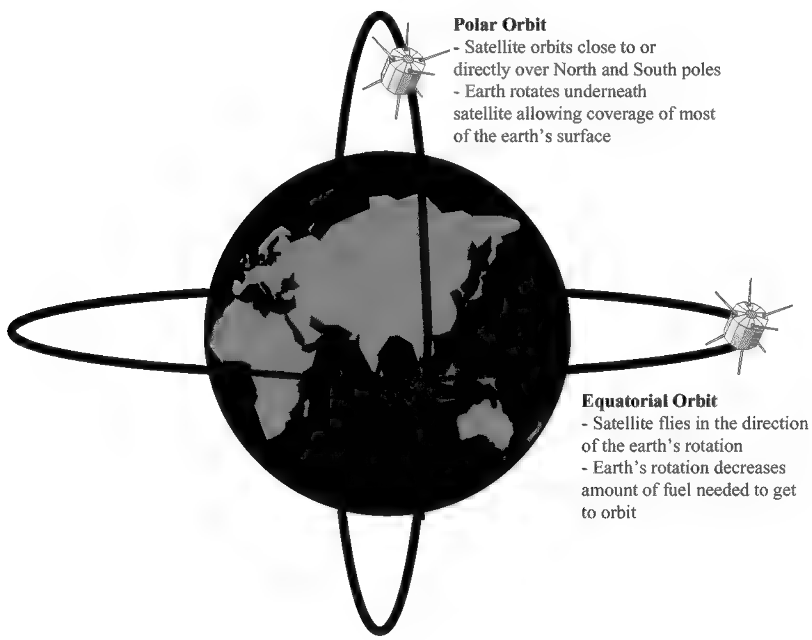

Figure 3. Basic Categories of Satellite Orbits

The orbit a satellite is placed in determines when it will be in view of a given point on the ground. It may be in constant view of the area, as in the case of a geosynchronous-orbiting communications satellite, or it may only be over the site for a few minutes a day. The orbit usually impacts when the satellite can perform its mission.

Space system users must often adjust their operational plans to account for when a satellite's orbit places it over the desired target area, instead of tasking the satellite to be over the target at a specific time like they would an aircraft. Operational planners need to keep these limitations in mind and also work with space system operators to see what orbit adjustments are possible to better support a given operation. For example, continuous imagery intelligence coverage of an given area could be accomplished by using space assets and aircraft such as the U-2, with the U-2 tasked to fill the gaps in coverage caused by the satellite's orbit.

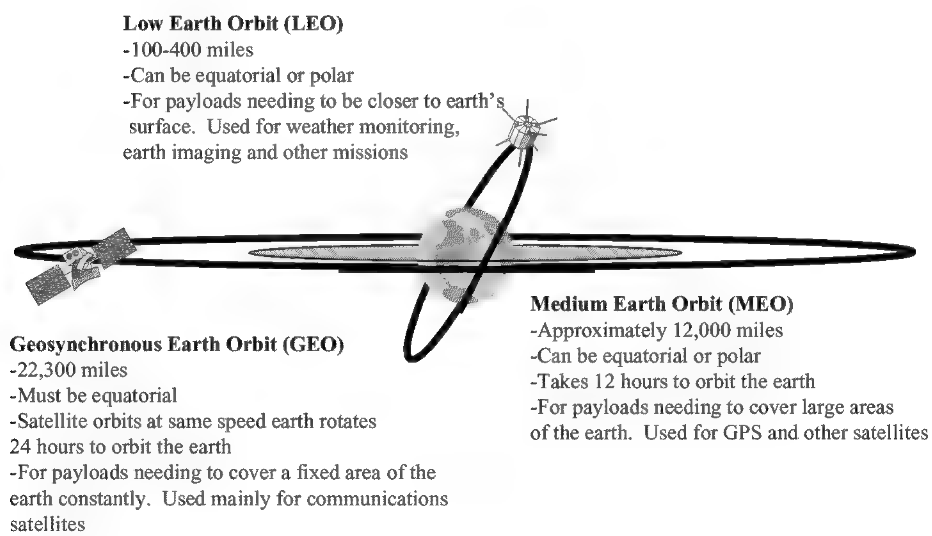

Figure 4. Three Most Common Types of Satellite Orbits

The most important consideration for military planners after orbital dynamics is the difficulty of getting a satellite into orbit in the first place. The cost is very high, schedules are very long and there are only a few places in CONUS from which you can launch. On average it costs $10,000 per pound to place a single satellite in orbit.[1]

Considering that an average medium-sized satellite weighs between 3,000 and 5,000 pounds, it is easy to see spending $30 -$50 million per satellite just for launch costs. It also takes between 60 days and 10 months to prepare and launch an already built satellite.[2] This means that if a conflict breaks out tomorrow, we must be prepared to fight it with whatever assets we have on orbit today. We will not be able to add more satellites or replace any that may break during the conflict. This is contrary to the goal of spacelift defined in AFDD-1. AFDD-1 calls for spacelift to be responsive enough to deploy new assets or sustain/augment current constellations during times of increased tensions. High launch costs, long launch processing schedules and limited resources all combine to make this view of spacelift a long-term goal.

Safety considerations and the need for expensive launch vehicle and satellite processing facilities limit the number of places from which you can launch a satellite. There are only three sites available in CONUS: Vandenberg AFB, California, Cape Canaveral, Florida, and Wallops Island, Virginia. The orbits that can be reached from each location are also limited by safety considerations. Specifically, launch vehicles must be able to fly satellites to their designated orbits without passing too close to a populated area. Vandenberg is the only place in CONUS from which you can launch a satellite into polar orbit without passing over a populated area. The air-launched Pegasus launch vehicle, built by Orbital Sciences Corporation, is free of such ground restrictions, but is only capable of placing small payloads of less than 1000 pounds into orbit. Table 1 below summarizes the key differences between air and space forces by using some of the unique characteristics of aerospace power found in AFDD-1, *Air Force Basic Doctrine*.

Table 1. Air and Space Comparison

Unique Characteristics of Aerospace Power	*Air Medium/Aircraft*	*Space Medium/Spacecraft*
Speed		
- Values	- 1,000 mph	- 17,000-25,000 mph
- Propulsion Mechanism	- Vehicle lift provided by wings, governed by laws of aerodynamics - Internal Combustion engine using atmospheric oxygen	- VEHICLE LIFT PROVIDED BY PROPULSION MECHANISM, GOVERNED BY LAWS OF ORBITAL MECHANICS - Combustion engine with oxidizer carried on vehicle
Range		
- Altitude	- 0-60 miles (approx.)	- 60 miles plus
- Distance	- Global (with refueling) in a matter of hours	-Global in about 90 minutes (for Low Earth Orbit) Higher orbits can provide instantaneous coverage of entire hemisphere
Freedom to Maneuver		
- Loiter over target	- Hours (fuel dependent)	- Minutes to Years (orbit dependent)
- TIME TO PLAN AND EXECUTE CHANGE OF HEADING	- Seconds	- Days/Weeks
- Range of possible heading changes	- 360 degrees	- EXTREMELY LIMITED, USUALLY BY FUEL. ORBIT ALTITUDE EASIER TO CHANGE THAN ORBITAL INCLINATION
-TAKE-OFF AND LANDING LIMITING FACTORS	- RUNWAY LENGTH - Weather conditions	- LAUNCH PAD AND LAUNCH RANGE INFRASTRUCTURE - WEATHER CONDITIONS

- TAKE-OFF AND LANDING LOCATIONS	**- Thousands**	**- 3 sites in CONUS with several launch pads per site**
- Sortie Rate	**- Many per day**	**- 1 launch per launch pad every 3-6 months**
- Sortie Generation	**- Hours per aircraft**	**- Months/years per satellite**
- Upgrade Capability	**- AS REQUIRED**	**- SOFTWARE CHANGES ON ORBIT**
Lethality		
Precision Weapon Delivery	**Weapon system dependent**	**None (limited by treaty and national policy)**
Weapon Type	**Conventional, Weapons of Mass Destruction (WMD)**	**None (WMD banned by treaty, conventional banned by policy)**

Source: Adapted from *Space is a Different Place,* Colonel Gordon T. Middleton, Maxwell AFB, AL, 1992.

Space Law

An often overlooked difference between air and space are the laws regarding travel through the two media. Air travel over foreign countries is tightly controlled. The airspace over a nation is considered part of the nation's sovereign territory. The same cannot be said for space. Article II of the United Nations Outer Space Treaty of 1967 states:

> Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means or use of occupation or by any other means.

American support of this treaty was a direct outcome of President Eisenhower's "Space for Peaceful Purposes" campaign. Even before any nation had launched a satellite, Eisenhower was focused on making space open so that any satellite could overfly any nation. He wanted this freedom so that military reconnaissance satellites, in development at the time, could overfly the Soviet Union and hopefully warn in advance of impending attacks. Project Vanguard, America's first attempt to launch a satellite, was

intended to establish this freedom of navigation.[3] The launch of Sputnik 1 in 1957, actually accomplished that mission, permanently establishing the "open skies policy" for space that was later codified in the 1967 Outerspace Treaty. Eisenhower tested this freedom of navigation four days after the shootdown of Gary Powers' U-2 over the Soviet Union. On that day he approved the launch of America's first space reconnaissance vehicle, a basketball-sized signals intelligence satellite.[4]

The Outer Space Treaty also bans placement of weapons of mass destruction in space. Many people think it also bans placement of any weapons in space. Although the Anti-Ballistic Missile (ABM) Treaty prevents the United States and Russia from placing conventional ABM weapons in space, the United States chose not to place any other types of conventional weapons in space. President Eisenhower thought we had more to lose from an arms race in space than the Russians would.[5] He believed that the closed nature of Russian society and the open nature of ours made satellite reconnaissance much more valuable to us than it did to them. This combination of presidential policy and international treaty prevented an escalation of satellite armaments from happening in the same way aircraft armaments escalated after the initial success of aerial reconnaissance in World War I.

Understanding space systems and the unique characteristics of the space medium gives us a foundation upon which to build space theory. We can now compare the unique aspects of space with classical war theories and thus develop our own space theory.

Notes

[1] House, *Statements by Daniel S. Goldin, NASA Administrator, before the Subcommittee on Space and Aeronautics, Committee on Science*, 104th Cong., 2d sess., 1996, 11.

Notes

[2] Joseph C. Anselmo, "Launch Upgrades Key to Milspace Evolution," *Aviation Week and Space Technology*, 1 September 1997, 48. Reported that it takes 60 days to process a GPS satellite on a Delta II, a process that has been done more than two dozen times. More unique and complex NRO satellite could take up to 10 months.

[3] R. Cargill Hall and Jacob Neufeld, eds., *The United States Air Force in Space 1945 to the 21st Century,* (Andrews AFB, MD: USAF History and Museums Program, 1995), 33.

[4] Phillip J. Klass and Joseph C. Anselmo, "NRO Lifts Veil on First Sigint Mission," *Aviation Week and Space Technology*, 22 June 1998, 32. Under the cover name of Galactic Radiation and Background, the satellite was launched from Vandenburg AFB on a Scout launch vehicle on 22 June 1960, 2 months before the first successful CORONA imagery intelligence mission.

[5] Major Roger C. Hunter, "U.S. ASAT Policy for a Multi-polar World," (School of Advanced Airpower Studies, Maxwell AFB, AL, 1992), 20.

Chapter 3

Development of Space Theory

Space must be integrated into our planning and practice. We should have space courses in every school at every level. We must practice to use space systems. Unless we practice it in every exercise, it will not be used in war.

—General Donald G. Kutyna, USAF (ret.)
Commander of U.S. Space Command during Operation DESERT STORM

[Theory] is meant to educate the mind of the future commander, or more accurately to guide him in his self-education, not to accompany him on the battlefield; just as a wise teacher guides and stimulates a young man's intellectual development, but is careful not to lead him by the hand for the rest of his life.

—Carl von Clausewitz

Basics of Theory

The *Oxford American Dictionary* defines *theory* as:

> A set of ideas formulated (by reasoning from known facts) to explain something, or a statement of principles on which a subject is based.

Clausewitz believed that theory existed so that someone did not need to "start afresh" every time they were faced with a new situation. They instead could have some existing thoughts and ideas to build on in order to prepare for military operations.[1] British naval theorist Julian Corbett emphasized that theory was essential for leaders at all levels of command to understand the overall military objective(s) of the senior commander.

> It is not enough that a leader should have the ability to decide rightly; his subordinates must seize at once the full meaning of his decision and be able to express it with certainty in well-adjusted action.[2]

The intent of the space theory detailed below is to provide a common understanding of space to all levels of military command so that space can be more effectively integrated into military operations.

Comparative Analysis

Corbett developed his theory of naval operations through a process he called "historical comparative analysis," looking back through history to determine certain basic patterns of action in given situations. He believed that naval theory must be based on basic war theory because success in war required linkage between Army and Navy. Warfare in one medium must support warfare in the others to attain the overall object of the military operation.[3] Similarly, I think we can relate space theory to basic war theory to promote the linkage of space operations with operations in other media.

Corbett's approach is useful as a basis for space theory because of his linkage to basic war theory and because of the many striking similarities between operations at sea and in space. Key similarities between space and sea operations include the vastness of the medium, the ways vessels navigate through the medium, how those vessels are controlled and the laws governing travel through the medium. Corbett's theory of naval warfare included three areas: Command of the Sea, Constitution of the Fleet and Concentration and Dispersal of Forces. His approach to constitution of the fleet is focused more on nineteenth century technology and is, therefore, somewhat dated. He did not anticipate the impact of submarines or aircraft carriers on naval warfare, among other things.[4] The remaining parts of his theory, however, provide a set of sound

principles just as relevant to twenty-first century space operations as they were to early twentieth century sea operations.

Lines of Communication

> *The only right we or our enemy have at sea is the right of passage; in other words the only value which the high seas have for national life is as a means of communication.*
>
> *The object of naval warfare is the control of communications and not as in land warfare the conquest of territory.*
>
> Sir Julian Corbettt

Corbettt linked command of the sea with control of sea lines of communication (LOCs). Control of the sea is a totally different challenge than control of land because of the vastness of the sea and the lack of national sovereignty over all but a few miles of coastal waters. Land warfare LOCs focused on lines of military supply for the ground army. Controlling these land LOCs was vital for military victory, but did not guarantee command of the land. Most of the enemy's territory had to be conquered to gain command of the land. Controlling sea LOCs, however, had a significant strategic effect without conquering territory because it was possible to directly impact the military and commercial vitality of a nation by controlling their ability to travel through the medium.[5]

Corbett said the object of naval warfare must always be, directly or indirectly, to secure command of the sea *or* (emphasis added) prevent the enemy from doing it.[6] Command of the sea, in Corbett's view, means a nation has secured freedom of operation for its forces. It does not necessarily mean that nation has prevented its enemies from using the medium. This is very similar to the concept of Air and Space Superiority defined in AFDD-1. AFDD-1 states that:

> Superiority is that degree of dominance that permits friendly land, sea and air forces to operate at a given time and place without prohibitive interference by the opposing force

Corbett's view of "command," like AFDD-1's view of "superiority" realized that absolute control of the medium was not essential for effective operations in the medium.

The vastness of space, like the vastness of sea, makes total control of the medium impossible. Similarly, no nation can claim sovereignty over space so, like the sea, the only way to exercise command of space is to control the right of passage through space. This control of passage applies both to the physical satellites and the data communications between the ground and the satellites. These are the space LOCs.

At sea, LOCs are the physical routes along which ships travel. In space, they could be physical or electromagnetic.[7] Physical LOCs for space are the path a launch vehicle takes to insert a satellite in orbit, the orbit in which the satellite is finally inserted, or the path taken by a missile warhead or other weapon to physically project force from space. Electromagnetic LOCs are the radio frequency links between the satellite and the ground including the command link, the data link and the user link (see Figure 2). It is also possible to include a landline that gets space data to a user as a space LOC. Interdicting this line could stop the flow of data from space to the user just as effectively as the loss of the actual satellite would. Either way the effect of space is denied to the user.

Corbett listed the three critical aspects of sea LOCs as common routes, choke points and harbors. Similar characteristics of space LOCs include common orbits, choke points and launch facilities.

Common Routes

Common routes, in some cases referred to as "great trade routes," are those navigable ocean routes through which most sea commerce passes. Though the ocean is vast, ship traffic must transit specific routes to be commercially and militarily of value. These routes usually provide the shortest distance between the port of origin and the port of destination (i.e. going through the Panama Canal instead of going around South America). They also take full advantage of favorable currents (and winds during the time of sailing ships). Finally, they avoid dangerous areas such as ice fields that may threaten the safety of the ship. Satellite orbits exhibit many of these same characteristics.

The nature of a satellite mission determines the characteristics of the orbit. The "great trade route" for most telecommunications satellites is geosynchronous orbit, at approximately 22,300 miles altitude. The speed a satellite must travel in this orbit equals the speed at which the earth rotates. This allows satellites to remain relatively fixed over one point on the ground, thereby allowing access to them with relatively cheap fixed antennas. Positions in this orbit are held at a premium and, therefore, pose a potential for international economic conflict since the satellite needs to be close to or directly over the area it serves. It does no good for a satellite serving India to be placed in orbit over the eastern United States. Many weather and earth reconnaissance satellites must be in low earth orbit for their sensors to be close enough to the earth to be effective. New satellite orbits are also positioned to avoid collisions with other satellites and space junk. Of the 8,000 objects tracked by USSPC in 1998, only seven percent were actual operating satellites.[8] The rest is junk ranging from old satellites and rockets to debris about the size of a softball.

Though space is even more vast than the oceans, the laws of orbital mechanics dictate that there are only certain routes in space through which satellites can travel to accomplish their missions given their payload capabilities and limitations. By identifying these routes, it is possible to identify choke points where the flow of space data to the user on the ground can be stopped and thus negate the effect of space for that user.

Choke Points

At sea, LOCs flow through choke points, places where the sea narrowly passes between two landmasses. These choke points have been essential for maritime control in the past. Control of Gibraltar and later the Suez Canal allowed the British to exercise control over traffic sailing to and from the Mediterranean Sea. Satellites encounter similar choke points in space. These choke points occur in two places. First, where a physical LOC intersects an electromagnetic LOC (i.e. the point in satellite orbit where it communicates with the ground or user segments), and second, where an electromagnetic LOC intersects with a segment (space, ground or user). See Figure 5 below.

Stopping the flow of data at any of these points will effectively cut the space LOC and negate the effect of the space system for the user. Stopping the flow of command data from a ground station to a satellite could render that satellite ineffective for days, possibly forever. Stopping the flow of data from the satellite to the user also negates the effect of that space system. The duration of the impact depends on how the data was stopped. Was it jammed temporarily or was there a physical attack against part of the space system?

Some newer satellite systems have satellite-to-satellite communications capability. These satellite cross-links provide more paths to get data to the user, but do not change

the fundamental nature of the choke point. Jamming the uplink to one of these satellites, for example, will mean there is no data to cross-link to another satellite, thus denying the effect of that space system.

This LOC theory applies to potential space weapons as well. Look at the portion of Figure 5 where the LOC is labeled “weapon effect” the ground segment is replaced with “target.” The effect could be a laser, kinetic energy or other notional space weapon. The rules governing the medium of space still apply. The LOC theory still applies as well. The space weapon is only effective when its orbit puts it in view of the target area. If you could stop ground commands from reaching the space weapon via the electromagnetic LOC, you could stop the weapon’s effect on the battlefield. Likewise if you could counter the “weapon effect” by somehow diverting the path of the weapon to it’s target, you could deny the effect of the space weapon.

The LOC theory is embodied in the Air Force concept of Offensive Counter Space (OCS), described in AFDD-1. OCS operations destroy or neutralize an adversary’s space systems or the information they provide through attacks on the space, terrestrial, or link elements of space systems.[9] Attacking any of these components could result in denying the effects of the entire space system that is being targeted.

Harbor Access

Corbett’s maritime strategy also identified blockage of ports as an effective method of sea control.[10] Keeping a ship “bottled up” in a harbor was just as effective as interdicting it somewhere on the high seas or at a choke point. Blocking a satellite launch vehicle from leaving the launch pad has the same effect for space. Like harbors, the size and complexity of equipment, along with stringent requirements for geographic location,

limit the number of launch sites. Launch sites represent decisive points through which we can impact an enemy's access to space and protect our own. Force protection measures for our launch, satellite processing and ground control facilities are therefore essential if we are to receive maximum possible benefit from our space systems. A well-trained Special Forces soldier with a $200 satchel charge could easily deny the effect of a $1 billion space system by destroying a key facility or satellite waiting to be launched, if proper protective measures are not taken.[11]

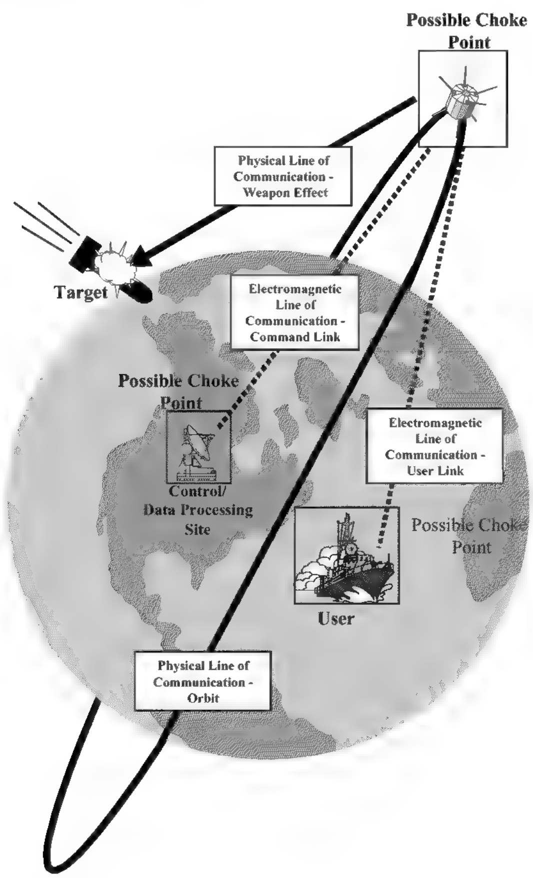

Figure 5. Space Choke Points and Lines of Communication

Concentration and Dispersal of Forces

> *Such is concentration reasonably understood; not huddled together like a drove of sheep, but distributed with regard to a common purpose, linked together by the effectual energy of a single will.*
>
> Alfred Thayer Mahan

> *A vital concept of air and space forces is the inherent ability to accomplish simultaneous strategic, operational and tactical effect-to conduct parallel operations-and attain overwhelming effect (concentration of purpose) through carefully dispersed applications.*
>
> AFDD-1

Corbett said concentration and dispersal of forces at sea were very much different than on land due to the nature of the medium of operation. The large size of armies and the physical restrictions of movements on land (mountains, rivers, valleys, etc.) required armies to remain more physically concentrated than sea forces in order to maximize their effect. At sea there are few restrictions on mobility for yourself or your enemy. This calls for a greater flexibility in operations and more dispersal of forces. Corbett notes that "the most distant and widely dispersed points must be kept in view as possible objectives of the enemy."[12] Warfare at sea requires a constant balance between concentration for proper effect and dispersal for proper coverage. This need is present in land warfare as well, but the vastness of the sea makes the balance much more challenging.

Space forces, in war and peacetime, face similar challenges. The speed and altitude of space systems allow them to cover vast portions of the earth quickly. It also means they can usually remain in view of a given point on the ground for only a few minutes at a time. This unique combination of speed, range and limited coverage time creates great challenges for space system users.

Space systems, like military transport aircraft, are in demand all over the world, not just in the current zones of conflict. Commanders must understand which portions of a space system they can and cannot control directly. Regional Commanders-in-Chief (CINCs) cannot expect to control all space segment assets, even in a conflict.[13] Many satellite assets may only be in the CINC's Area of Responsibility (AOR) for a few minutes per day. It is also highly unlikely that a satellite will be launched during a conflict to provide optimum coverage for an AOR, given the short nature of modern conflicts and the long processing and launch times of new space systems. Commanders in a conflict may enjoy higher priority in tasking satellites, but they will not have total control of the space system.

Ground processing and user segments of the space system are more easily concentrated in an AOR during times of conflict. These segments usually belong to the CINCs or their assigned forces. Concentration of these ground assets effectively means first making sure they get to theater in a timely manner in the event of a conflict. This was a major problem in Operation DESERT STORM as noted earlier. These assets should then be dispersed within theater to the places where they will be the most effective. Proper location of these ground processing and user segments will help ensure the right data gets to the right people at the right time and thus maximize the effect of the space system for the AOR.

Concentration and dispersal of forces relates closely to the "centralized control, decentralized execution" tenet of airpower described in AFDD-1. The vast area covered by space forces, the speed of coverage and limited resources necessitate centralized control of space forces to ensure users world-wide benefit from the effects of space

systems. Concentration of user and ground processing segments in an AOR enables decentralized execution of operations requiring space data, thus ensuring the most timely and accurate data is available to the lowest possible levels of command. This allows lower level commanders to maximize the effects of space for their forces and execute their missions to meet the Joint Forces Commander's intent.

To maximize our understanding of space, we will now combine our discussions of space systems, the medium of space and comparative analysis to develop the keys to space theory. These keys will capture the key concepts that people at all levels of command must understand to effectively integrate space forces into military operations.

Notes

[1] Carl von Clausewitz, *On War*, trans. Michael Howard and Peter Paret, (1976: reprint, Princeton NJ: Princeton University Press, 1984), 141.

[2] Julian S. Corbett, *Some Principles of Maritime Strategy,* (1911: new imprint, New York: AMS Press, 1972), 2.

[3] Ibid., 20.

[4] Ibid.

[5] Ibid., 91.

[6] Ibid., 87.

[7] Major Henry G. Franke III, "An Evolving Joint Space Campaign Concept and the Army's Role" (School of Advanced Military Studies, 1992), 18.

[8] Air Force Doctrine Document 2-2, *Space Operations*, (Maxwell AFB, AL: Headquarters Air Force Doctrine Center, 1998), 18.

[9] Air Force Doctrine Document 1, *Air Force Basic Doctrine*, (Maxwell AFB, AL: Headquarters Air Force Doctrine Center, 1997), 47.

[10] Julian S. Corbett, 93.

[11] James L. Rogers, "Future Warfare and the Space Campaign," in *Aerospace Operations Course Book* (Maxwell AFB, AL: Air Command and Staff College 1998), 95.

[12] Ibid., 134.

[13] Major Michael M. Garrell, "There are No Space Wars, How do the CINC's Fight Using Space Forces?" (Newport, RI: Naval War College, 1994), 18.

Chapter 4

The Keys to Space Theory

> *When the Germans invaded France in May 1940, they had fewer men, fewer artillery tubes and fewer tanks. But they had revolutionary operational concepts for employing their systems to achieve battlefield effects far greater than the sum of the parts. The Allies learned the hard lesson that how you employ technology is even more important that the technology itself. The quality of our people, the caliber of our leaders and the operational concepts and doctrine we use to employ technology on the battlefield, they are the decisive factors.*
>
> —General Henry H. Shelton, Chairman of the Joint Chiefs of Staff

Theory must be effectively communicated at all levels of command to provide the common knowledge base essential for unity of effort that was envisioned by Clausewitz, Corbett and others. Successful space theory must help commanders and operators understand the effects of space, the limitations of those effects and how those effects can be maximized for successful military operations. To have a complete vision of space we need to tie the theoretical concepts of command of space through control of space LOCs and concentration and dispersal of space assets with the basics of space discussed earlier. I propose to do this through four key principles on which all space operations can be based. They are:

- Control of Space Means Controlling the Effects from Space
- Access to Space is Everything
- The Primary Users of Space are not Space Operators
- Space is a National Center of Gravity for the U.S. and our Enemies

Control of Space Means Controlling the Effects from Space

By denying the enemy this means of passage we check the movement of his national life at sea in the same way we check it on land by occupying his territory.

Julian S. Corbett

Stopping information from moving through space has the same relative effect on military operations as that of stopping ships moving through the ocean. German U-boats attempted to cut sea LOCs from the U.S. to Europe in World War II by attacking supply convoys. Similarly, the effects of space can be denied by cutting the flow of information through space LOCs. Cutting these space LOCs means impacting some portion of the space, ground or user segment of the space system or cutting off the links between them. The loss of any segment or link between segments could completely eliminate the effect of that space system on military operations.

Denying the effect of space, therefore, does not necessarily mean using some kind of anti-satellite weapon. It could be as simple as targeting a critical ground station with conventional weapons or electronic jamming of a link as noted in AFDD-1. Today, for example, the precision navigation and timing effects of the multi-billion dollar GPS network could be denied in a given target area by a jammer costing less than $300.[1] Accomplishing the same *effect* with ASAT weapons could cost millions of dollars, take weeks or even months to accomplish and most likely cause a significant international incident.[2]

Remember that like Corbett's command of the sea, denying the effects of space to the enemy and protecting our own space effects are two different things. We may protect our space LOCs and achieve command of space, or space superiority in AFDD-1 terms,

for ourselves without denying command of space to the enemy. This was the Cold War strategy started by President Eisenhower. Both the Russians and the United States had space superiority, because neither side opposed the transit of each other's satellites and space information through space. We or our potential adversaries may decide in the future, however, that interdicting enemy space LOCs is essential for victory. Those planning for future operations must consider all segments of friendly and enemy space systems so that our assets can be properly protected and our enemy's can be properly targeted. A key part of protecting our assets is our ability to access space.

Access is Everything

> *Cheap access to space is extremely important to us. If we have only so much money and we spend 50% of it just to get to space, that leaves us only 50% to spend on things in space.*
>
> —General Howell Estes,
> former Commander, U.S. Space Command

You cannot use space if you cannot first get to space, then get your data back from space or project power from space. Key considerations for access are reliability, affordability and survivability. Reliable access means having robust systems and keeping your physical and electromagnetic space LOCs open during peacetime and conflict. Reliability requires investment in the launch and ground control/processing segments of the space system. American naval strategist Alfred Thayer Mahan considered the offensive strength of a strategic port to be its capacity, how many ships it could hold and how quickly it could put them to sea.[3] The "offensive strength" of our launch sites is critical to maintaining our physical space LOCs. Manifests for Cape Canaveral in 1999 call for 49 launches, but the site only has the capacity for 43.[4] Limitations like this must

be addressed to ensure our space systems can provide the desired effects we need from successful military space operations and keep up with increasing commercial launch demands.

Reliability also relates to affordability. Future projections call for reusable launch vehicles to drop the cost of access to orbit from $10,000 per pound to $1000 per pound. Such cost improvements could put more space systems in orbit to support military operations.[5] These savings can only be achieved with improved technologies and higher launch rates. Military planners the world over must understand that investments in launch facilities thousands of miles away from their AOR are essential for them to maximize the benefits of space within their AOR.

The same goes for the ground control, ground processing and user segments. Maximizing the effects of space requires these sites to be reliable and affordable in peace and in war. The C-5 sized imagery intelligence system deployed to DESERT STORM was recently replaced with a system requiring only six two-man-liftable transit cases. This system costs less, is more reliable and is much easier to transport to theater, which makes it easier to get more benefit from particular space systems.

Survivability means taking measures to ensure all segments of a space system are protected from attack. It means taking active and passive measures to protect space assets in orbit and on the ground. This is captured in the function of Defensive Counter Space described in AFDD-1.[6]

The Primary Users of Space are not Space Operators

We knew almost nothing about the space assets that were already available to support our forces.

Lieutenant General Ronald R. Fogleman, Commander Seventh Air Force
Immediately after Operation DESERT STORM

As Commander of Seventh Air Force, Lieutenant General Ronald R. Fogleman (who later became Chief of Staff of the Air Force) watched with great interest as Operation DESERT STORM succeeded outstandingly with substantial space support. Wanting to have these same tools to support his forces in Korea, he requested an assessment by USSPC to determine how long it would take them to provide him with those same capabilities. To his embarrassment he was told he already had all of the capabilities General Schwartzkopf had in DESERT STORM.[7] General Fogleman attributed this lack of understanding to several valid points. First, classification kept many in his command and elsewhere from knowing what space assets could really provide them. It is only in the last few years that the existence of organizations like the NRO has been officially recognized at the unclassified level. Second, there was general ignorance of how space was already supporting daily operations in Korea because of how tightly some space systems were already integrated into daily operations. He did not know that "the big antenna next to the white van surrounded by security fence" at Osan Air Base, Korea was in fact a DMSP downlink facility and the source of much of his weather data.[8]

The good news was that space assets were already integrated into his forces. The bad news was that this lower level integration often kept higher level commanders from understanding just how much space did for them. AFDD 2, *Employment of Air and Space Forces,* provides some insight into this problem. In the air operations center (AOC) it designates the A-2 (intelligence) as the person responsible for coordinating intelligence support to include collection management for national space intelligence systems. AFDD 2 designates the A-6 (computers and communications) as the point of

contact to work with DISA to obtain commercial communications capability including commercial satellite communications. There is no single person who represents all of space to the AOC or the CINC. The deployment of Space Warfare Officers to the Numbered Air Forces discussed earlier will help alleviate this problem, but it will not eliminate the need for non-space operators and planners to understand space.

Maximizing the effect of space on military operations requires many people on both the operations and planning staffs to understand the basics of space systems. Logistics planners must know to include user and ground processing equipment in the Time Phased Force Deployment Data to ensure deployed forces have proper access to space. Security forces must understand the importance of space-related ground facilities and the need to provide proper protection for them. Targeteers must understand how our enemies use space so they can select the best available weapons to deny the effects of space to those enemies. Senior leaders must understand space to ensure we maintain the investment necessary to sustain our advantage in space. They must also deal with the many political, diplomatic and military challenges of the potential deployment of space weapons. A common understanding of space among all these parties is necessary for the unity of effort required to maximize the use of space for our forces and deny those same effects to our enemies. The need for unity of effort increases as space grows in importance as both a military and economic center of gravity.

Space is a National Center of Gravity for the U.S. and our Enemies

Space systems have become increasingly popular for commercial applications. This creates advantages and disadvantages for the military. Commercial communications satellites augment oversubscribed military capabilities to provide vital communications

for deployed forces. However, the proliferation of commercial space capabilities has also created an economic center of gravity that we must protect. Nearly half of the 600 plus satellites in orbit today are American. They represent an investment of more than $100 billion. It is estimated that 1,800 more satellites will be placed on orbit in the next decade.[9] The loss of just one satellite, Galaxy IV on 19 May 1998, cut service to 35 million pagers, several television and radio stations, and left numerous self-service gas pumps inoperative because they could not link to distant computers to verify a customer's credit card.[10] Imagine the impact if a potential enemy could do that on purpose.

The distinction between military and economic centers of gravity for space is blurring. Expanding commercial space capabilities for imagery, navigation, weather and communication not only increase their economic importance but provide an easily obtainable space capability to adversaries who, until recently, may have had none. Military space systems increasingly rely on commercial technology developments to provide more capability at less cost. Military facilities also continue to provide much of the launch and control infrastructure used by commercial space operators and users.[11] Maintaining command of space for the United States requires that we make the effort needed to maintain both commercial and military space LOCs just as our Navy and Coast Guard does today with sea LOCs. We must maintain the national infrastructure necessary to ensure access to space and control of assets in space. Failing to appreciate the significance of space as an economic and military center of gravity will jeopardize our ability to maintain space superiority now and in any future conflict.

Notes

[1] Bruce D. Nordwall, "Navwar Expands EW Challenge," *Aviation Week and Space Technology,* 23 November 1998, 57.

Notes

[2] There are 24 satellites in the current GPS constellation. Assume you could figure our which 8 of those satellite needed to be destroyed to accomplish your desired effect of denying service in a given target area. Now, since each of these satellites are probably in different orbits you would need 8 separate launches of your ASAT weapon. Assuming a very small ASAT weapon of 500lbs, at $10,000/lb launch cost, it would cost $5M for each ASAT launch or $40M to effect all 8 satellites, assuming each mission was successful. No country has the capability to launch 8 separate missions in less than 2 months.

[3] Alfred Thayer Mahan, "Naval Strategy Compared and Contrasted with Principles and Practice of Military Operations on Land," in *The Art of War in World History*, ed. Gerard Chaliand, (Berkley, CA: University of California Press, 1994), 802.

[4] William B. Scott, "CINCSPACE Wants Attack Detectors on Satellites," *Aviation Week and Space Technology*, 10 August 1998, 22.

[5] Ibid., 23.

[6] AFDD 1 defines the mission of Defensive Counter Space as "active and passive actions to protect our space-related capabilities from enemy attack or interference." This could include things such as making satellites able to passively withstand possible attacks or actively maneuver out of the way of an attack. It also could mean protecting ground based segments of the space system such as those related to satellite launch and operations.

[7] R. Cargill Hall and Jacob Neufeld, ed., *The United States Air Force in Space 1945 to the 21st Century* (Andrews AFB, MD, 1995.: USAF History and Museums Program), 6.

[8] Ibid.

[9] General Howell M. Estes, "Protecting America's Investment in Space"; on-line, Internet, 16 January 1999, available from http://www.afspc.af.mil.

[10] John T. Correll, "Destiny in Space," *Air Force Magazine,* August 1998, 2.

[11] Military launch bases of Vandenberg AFB, CA and Cape Canaveral, FL are still the primary CONUS launch sites. Many contractors are building and/or upgrading their own processing facilities on these bases, but they still rely on the military infrastructure for launching their satellites and tracking them once in orbit.

Chapter 5

Conclusion

An opportunity for us and our adversaries; A lead we cannot lose; An asset we must protect.

National Defense Panel Report on Space, 1997

Space system use in military operations has continued to increase since the dramatic success of space support in DESERT STORM. Military personnel do not see space systems fly over the battlefield in formation, yet they depend on them every day for weather forecasting, communications, precision navigation, missile warning and timely intelligence. Achieving the "full force integration" of space systems envisioned by USSPC's Long Range Plan will require commanders, planners and operators at all levels to understand basics of space systems, the nature of the space medium and the theory behind space operations. The diverse group of organizations involved in space and the explosive growth of commercial space, with its benefits for both the United States and our enemies, increases this integration challenge.

Much of space technology is "rocket science" but understanding and managing the effects of space is not. The key theoretical concept of space LOCs in captured is the AFDD-1 mission of Offensive Counter Space. The idea that the effect of a space system can be denied in many ways short of the physical destruction of a satellite is key for planners to understand as they face opponents with ever increasing space capabilities.

Defensive Counterspace, as described by AFDD-1, emphasizes the need for survivability and force protection measures to ensure we continue to benefit from the effects of both military and commercial space systems in peacetime and in conflict. Maximizing the effect of our space systems will also require effective control of those assets.

Applying Corbett's idea of effective concentration and dispersal of sea forces to space forces emphasizes the need for centralized control and decentralized execution. Centralized control is essential for space assets that may cover every CINC AOR during a single 90-minute orbit. Decentralized execution in the deployment of space system user and ground segments to theater will ensure the right data gets to the right person at the right time.

Making all this happen will require personnel around the world to have a common understanding of how to maximize the benefits of space in military operations. Planners and operators must understand the need for a robust and often expensive infrastructure in CONUS to support the launch and operation of our space systems. They must also understand the limitations of space systems caused by orbital mechanics and the cost and time required to execute a satellite launch. Space system builders and operators must understand that the primary users of space data are not space operators. They must focus their efforts on education and integration, through key personnel such as the Space Warfare Officer, to ensure personnel at all levels of command understand how to maximize the effects of space for their operations.

Finally, military and civilians alike must understand how space has become both a commercial and military center of gravity for ourselves and our potential enemies. The growing worldwide commercial industry offers enhanced technology at reduced cost for

our military systems. It also offers enemies with little space experience a fast and cheap way to obtain significant space capabilities. Protecting these centers of gravity for ourselves and denying them to the enemy will be the key to maintaining space superiority in the future. Common understanding of space systems, the effect of the space medium on military operations and the keys to space theory will ensure we are able to maximize the effects of space, for ourselves and our allies, and maintain space superiority into the twenty-first century.

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